
CLAIMS

[Claim(s)]
[Claim 1] It is the color picture display characterized by having the spectral distribution from which said each coloring matter child differs in the color picture display with which 1 pixel consists of three or more coloring matter children, respectively, and having a value within the limits whose bandwidth of the passage or reflection in each coloring matter child's spectral distribution is 0.43 to 0.57 times the bandwidth of a visible region, respectively.
[Claim 2] It is the color picture display characterized by having the spectral distribution from which said each coloring matter child differs in the color picture display with which 1 pixel consists of four coloring matter children, respectively, and for the band of the passage or reflection in each coloring matter child's spectral distribution lapping in part mutually, and these coloring matter child having comparable bandwidth.
[Claim 3] The band of passage or reflection is a color picture display with which it is characterized by being 480nm and about 630nm to 700nm from about 550nm, about 700nm from the wavelength of about 550nm, 630nm from the wavelength of about 480nm and the wavelength of about 400nm from the wavelength of about 400nm, respectively. [in / on the color picture display with which 1 pixel consists of the 1st thru/or 4th four coloring matter child, and / said 1st thru/or 4th coloring matter child's spectral characteristic]
[Claim 4] It is the color picture display characterized by for said 4 coloring-matter child adjoining every direction 2 coloring-matter child [every] each other in the color picture display with which 1 pixel consists of four coloring matter children, being arranged, changing color three-primary-colors display-image data into four chrominance signals corresponding to said 4 coloring-matter child, and providing the means which carries out brightness control of said 4 coloring-matter child for every coloring matter child.
[Claim 5] The transparent mode mold which 1 pixel is constituted from four coloring matter children, and displays using the transmitted light, By performing color conversion which is the color picture display of the concomitant use mold which can change the reflective mode type displayed using the reflected light or these transparency, and reflective mode, and is different according to outdoor daylight or a display mode The color picture display characterized by providing a means to generate four chrominance signals corresponding to said 4 coloring-matter child from color three-primary-colors display-image data.
[Claim 6] It is the color filter arranged on each pixel which consists of two or more liquid crystal cells arranged in the shape of a matrix, and four liquid crystal cells which adjoined mutually two every direction at a time, and have been arranged. The color filter of four colors which have mutually different spectral distribution and have a value within the limits whose bandwidth of the passage or reflection in the spectral distribution of each color filter is 0.43 to 0.57 times the bandwidth of a visible region, respectively, The color picture display characterized by providing a means to change and output color three-primary-colors display-image data to four chrominance signals corresponding to the color filter of said four colors.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to a color picture display.
[0002]
[Description of the Prior Art] Generally, color picture displays, such as a color CRT display and a color liquid crystal display, are additive-mixture-of-colors displays, and a display is performed based on the three primary colors of red (R), green (G), and blue (B). Moreover, in the subtractive-color-mixture display of a color printer etc., the display is performed cyanogen (C), a Magenta (M), and based on the three primary colors of yellow (Y).
[0003] In the typical color liquid crystal display, it is trichotomized and 1 pixel of color filters with which a fundamental color consists of combination of three colors of red-green blue is used. However, if n division of 1 pixel is done in this way and the passband of the light in each divided field is also made into each number of partitions, white brightness will be set to 1 for the number of partitions when it expresses it with the sum of the fundamental color which constitutes a pixel also for expressing white, for example. That is, in trichotomy, the passband of the light in the each divided fundamental color is set to one third, respectively, and since the area of each of that color is 1/3, respectively, the use effectiveness of the light of filter 1 color is set to one ninth after all.
[0004] Since white is expressed and three fundamental colors are turned on now, respectively, the use effectiveness of light is set to 3x1/9, and serves as one third of brightness after all. Therefore, in such a color filter, even when displaying the white which is the brightest color, only use of one third of light can be performed. Therefore, in the reflective mold display of such a configuration, since it becomes dark, there is a fault of vividness also falling.
[0005] Moreover, if the configuration from which brightness sufficient in a transparency mold for a back light is obtained is taken, the skillful color specification also of such a configuration will become possible, but on the other hand a fault -- much power is needed for a back light drive -- arises. Moreover, in expressing 1 pixel with the component of two or more colors, in order to obtain the same resolution, it needed to manufacture with high definition only the two or more times, and there was un-arranging -- the manufacture becomes difficult -- on the relation of the yield.
[0006] So, recently, the liquid crystal display which carries out color display without using a color filter is devised (Nikkei micro device January issue 1994 P99). With this equipment, in carrying out a color expression, it changes the electrical potential difference applied to liquid crystal using the form birefringence of liquid crystal, and the color is expressed by making the birefringence effectiveness adjustable. However, although the difference in a color is controllable by this approach, since a gradation display is difficult, a free color expression cannot be performed.
[0007] Moreover, 1 pixel is divided into two and the reflective mold liquid crystal display with which each fundamental color used cyanogen and the color filter of Orange is known (Institute of Electronics, Information and Communication Engineers Vol. 77 No.3 pp.296-303 March, 1994). However, the expression only of the color of the color specification field on the flat surface to which two colors which are fundamental colors are connected with this approach was completed, but the full color expression was difficult for it.
[0008] Moreover, there is also an idea of saying that color specification is performed by the lap of a color like printing ("next-generation liquid crystal display technical" Tatsuo Uchida Kogyo Chosakai

Publishing publication (November 1, 1994) p172 written by editing reflective mold color LCD). However, since it is necessary to manufacture a liquid crystal panel in fact [in order to realize this method] in a laminating, the thickness in the layer of each color arises, and when it observes from across, there are problems, like the parallax of three colors arises. Furthermore, if it inquired in a detail, since the liquid crystal panel of three colors would lap, many reflectors in each class existed and, for a certain reason, the loss of the light in each class also had the problem of becoming [the liquid crystal display panel of a monolayer], and becoming the display of a dark image further.
[0009]
[Problem(s) to be Solved by the Invention] As mentioned above, in the color liquid crystal display which constitutes 1 pixel from a component of the color which consists of plurality, it was difficult to fill brightness and a low power to coincidence. Moreover, the more the number of pixels increases also in highly-minute-izing, the phase confrontation product of the wiring part for the black stripe and drive which separate a color and a color increases, and, the more brightness falls. Moreover, the blemish on manufacture and the effect of dirt became large, and only the part which becomes highly minute had the problem of the yield falling. Furthermore, a skillful color expression was able to be performed neither in the liquid crystal display which performs color display using form birefringence, nor the liquid crystal display using the color filter of two colors in a fundamental color.
[0010] While this invention was made in view of such a point and enables a bright display in the combination of the color filter with sufficient use effectiveness of light, it aims at offering the color picture [with which satisfaction goes practically] display which is skillful and can perform color display.
[Elements of the Invention]
[0011]
[Means for Solving the Problem] In order to attain the purpose mentioned above, 1 pixel is constituted from three or more coloring matter children, each coloring matter child has spectral distribution different, respectively, and the color picture display of this invention is characterized by making bandwidth of passage or reflection into the value within the limits of 0.43 to 0.57 times of the bandwidth of a visible region by each coloring matter child's spectral distribution, respectively.
[0012] Moreover, it is the color picture display of this invention constituting 1 pixel from four coloring matter children, piling up mutually passage of each coloring matter child or a reflective band in part in each coloring matter child's spectral characteristic, and making each coloring matter child's bandwidth into a comparable value further, and brightly, there are few saturation falls and they are characterized by enabling reappearance of the white of an achromatic color further mostly.
[0013] Moreover, the color picture display of this invention is set to the color picture display with which 1 pixel consists of the 1st thru/or 4th four coloring matter child. The band of the passage or reflection in said 1st thru/or 4th coloring matter child's spectral characteristic It is characterized by making it 700nm from 480nm and about 630nm from 630nm from about 550nm from the wavelength of about 400nm, about 700nm from the wavelength of about 550nm, and the wavelength of about 480nm, and the wavelength of about 400nm, respectively.
[0014] Moreover, the color picture display of this invention makes arrangement of 4 coloring-matter child who constitutes each pixel a vertical 2 coloring-matter child and the horizontal coloring matter child 2, changes color three-primary-colors display-image data into four chrominance signals corresponding to said 4 coloring-matter child, and is characterized by providing the means which carries out brightness control of said 4 coloring-matter child for every coloring matter child. Moreover, in case it changes and displays on four chrominance signals from color three-primary-colors display-image data, it is desirable to perform color conversion on the matrix conversion or the table of a multiplier which changes with color specification range expressed. Furthermore, the repeatability of the foreground color in a highly minute display is improvable by evaluating an error with the chromaticity of input image data with four adjoining coloring matter, and establishing a means to add amendment to the brightness control of the coloring matter child who adjoins according to the chromaticity error. moreover, the thing arranged as the coloring matter children arranged horizontally have a complementary color relation mostly, when arrangement of 4 coloring-matter child is made into a vertical 2 coloring-matter child and the horizontal coloring matter child 2

-- ** -- it is desirable.
[0015] Moreover, this invention is set to the color picture display of the concomitant use mold which can change the transparent mode mold displayed using the transmitted light, the reflective mode type displayed using the reflected light or these transparency, and reflective mode. It is characterized by providing a means to generate four chrominance signals corresponding to said 4 coloring-matter child from color three-primary-colors display-image data by constituting 1 pixel from four coloring matter children, and performing different color conversion according to the display mode or outdoor daylight of said color picture display.
[0016] Moreover, two or more liquid crystal cells by which this invention has been arranged in the shape of a matrix in the color liquid crystal display, It is the color filter arranged on each pixel which consists of four liquid crystal cells which adjoined mutually two every direction at a time, and have been arranged. The color filter of four colors which have mutually different spectral distribution and have a value within the limits whose bandwidth of the passage or reflection in the spectral distribution of each color filter is 0.43 to 0.57 times the bandwidth of a visible region, respectively, It is characterized by constituting from a means to change and output color three-primary-colors display-image data to four chrominance signals corresponding to the color filter of said four colors.
[0017] furthermore, in realizing the color liquid crystal display which trichotomizes 1 pixel and uses the color filter of three colors In order to raise the use effectiveness of light, 470 to 620nm penetrates a green system color filter. 670 to 700nm penetrates a blue system color filter. [400 to 520nm and] [whether a red system color filter uses the color filter characterized by 580 to 700nm consisting of transparency, and] [400 to 430nm and] Or 490 to 570nm penetrates a green system color filter, and 630 to 700nm penetrates transparency and a blue system color filter. [400 to 510nm and] As for a red system color filter, it is desirable to use the color filter with which 580 to 700nm consists of transparency. [400 to 430nm and]
[0018]
[Function] The available quantity of light in each coloring matter child can be raised about 3 / twice by making each coloring matter child's divided transparency, or reflective bandwidth into the value before and behind 1/2 of a visible region (i.e., within the limits of 0.43 to 0.57 times of the bandwidth of a visible region), respectively. Moreover, by controlling four colors to coincidence, the reappearance range of the important color of low saturation can be enough secured now on vision, and reservation of the balance of the color specification near the achromatic color becomes easy. Moreover, there is comparatively little effect in the color of high saturation seldom worried on vision. Moreover, while a twice [about] as many highly precise display as the resolution of the coloring matter child who constitutes 1 pixel from controlling the brightness control in each coloring matter child for every 1 coloring-matter child, i.e., a pixel, is attained, it becomes possible to suppress the color blot by the edge of such a display.
[0019]
[Example] Hereafter, the example of this invention is explained with reference to a drawing.
(Example 1) Drawing 1 is drawing showing the quadrisection type spectral characteristic of the electrochromatic display concerning this example. In this drawing, a filter 101 is a filter of a yellowy red color system (YR), and about 700nm penetrates it from the wavelength of about 550nm. A filter 102 is a filter of a copper rust color system (CB), and about 550nm penetrates it from the wavelength of about 400nm. A filter 103 is a filter of a green system (LG), 630nm of transparency and a filter 104 is the filter of a Magenta color system (LM) from the wavelength of about 480nm, and about 400nm wavelength to 480 nm and about 630nm - 700 nm are transparency. Although this drawing shows the spectral characteristic of an ideal color filter, a metaphor has a thing corresponding to the ZENRACHIN color filter made from KODAKKU in realizing mostly.
[0020] for example, the filter 101 -- KODAKKURATTEN gelatin filter NO.15 and a filter 102 -- this NO.47A and a filter 103 -- said -- NO.40 and a filter 104 -- said -- it is realizable by NO.30 etc.
[0021] Moreover, drawing 2 is drawing which has arranged spatially the four above-mentioned sorts of color filters. Here, 1 pixel, it consists of four components corresponding to four kinds of colors, and this is called 1 pixel. Moreover, the component of each color will be called a coloring matter child. Drawing 3 is the example constituted as a reflective mold liquid crystal panel. A color filter 301 is divided superficially and arranged by the black matrix 302. That is, drawing 2 serves as

drawing which looked at the reflective mold liquid crystal panel from the upper part, and drawing 3 shows the sectional view. In this case, four sorts of color filters of drawing 2 will be arranged on four liquid crystal cells which constitute 1 pixel.

[0022] Now, in drawing 3 , the transparent electrode 303 has been arranged at the liquid crystal side of a color filter 301, and the liquid crystal layer 305 is pinched with the counterelectrode (reflecting plate electrode) 304 which serves as a reflecting plate. In the reflective mold LCD, the phase transition mold guest host method which does not use a polarizing plate as liquid crystal is suitable from ****** with the need of if possible raising the use effectiveness of light. The reflecting plate electrode 304 is connected to TFT306, and the liquid crystal layer 305 is divided into two or more liquid crystal cells by which matrix arrangement was carried out by these reflecting plate electrode 304 and TFT306. A color picture is displayed because only the liquid crystal cell section chosen by TFT306 reflects or absorbs colored light.

[0023] Drawing 4 shows the example which uses this reflective mold liquid crystal panel as a display monitor of a personal computer. Image data is emitted from CPU401, is supplied to a graphic controller 403 through a bus 402, and is written in a frame memory 404. The image data written in the frame memory 404 is changed into four chrominance signals for liquid crystal displays (YR, CB, LG, LM) from RGB3 chrominance signal by the matrix circuit 405. These four chrominance signals are sent to the timing controller 406, are doubled with a horizontal/vertical synchronizing signal from a graphic controller 403, and are sent to the gradation electrical-potential-difference generating section 407. In the gradation electrical-potential-difference generating section 407, each chrominance signal of four chrominance signals is changed into the electrical potential difference of a multiple value, and it is supplied to a liquid crystal panel 409 through the source driver 408. Moreover, an electrical potential difference is supplied to the color pixel of the position of a liquid crystal panel 409 by work of a gate driver 410 and the source driver 408 at this time, brightness control is made by this for every color of YR, CB, LG, and LM, and a predetermined color is reproduced.

[0024] Now, the color specification nature of the liquid crystal display displayed by doing in this way is explained. Drawing 5 is a part of drawing 2 , and examines the model of liquid crystal with the juxtaposition color mixture model of the black matrix 501, the reflective part 502 of a color filter, and the absorption part 503. A strict examination is enough as it for practical examination in the case where an observation post examines a color specification region at the front of a panel, although such a model cannot describe the color specification of liquid crystal.

[0025] Now, the spectral characteristic of the color filter 101 of a yellowy red color system is set to Fy (r), and it asks for the chromaticities Xfy, Yfy, and Zfy by degree type (1-1) - (1-3). Here, S (r) is the light source for observation, or a source of the illumination light. X (r), Y (r), and Z (r) are the spectral characteristics of a tristimulus value.

[0026]

[Equation 1]

$$Xfy=\int_r S(r)\,Fy(r)\,X(r)\,d_r \Big/ \int_r S(r)\,Y(r)\,d_r \quad \cdots(1\text{-}1)$$

$$Yfy=\int_r S(r)\,Fy(r)\,Y(r)\,d_r \Big/ \int_r S(r)\,Y(r)\,d_r \quad \cdots(1\text{-}2)$$

$$Zfy=\int_r S(r)\,Fy(r)\,Z(r)\,d_r \Big/ \int_r S(r)\,Y(r)\,d_r \quad \cdots(1\text{-}3)$$

[0027] Similarly, the spectral characteristic of the filter 102 of a copper rust color system is set to Fc (r), and it asks for the chromaticities Xfc, Yfc, and Zfc. Moreover, it asks for the chromaticities Xfg, Yfg, and Zfg of the green system filter 103, and the chromaticities Xfm, Yfm, and Zfm of the Magenta color system filter 104. Similarly, the color of black matrix 501 part to avoid color mixture is asked for the chromaticities Xfo, Yfo, and Zfo at the time of Xkb, Ykb, Zkb, and OFF of each color filter. In addition, the spectral characteristic of the liquid crystal itself is included in a color filter here, and is examined. It can ask for the chromaticities X, Y, and Z of a display by degree type (2-1) - (2-3) from the model of juxtaposition color mixture.

[0028]

[Equation 2]

$$X = 1/m \cdot \sum_{n=1}^{m} (AR \cdot (An \cdot Xfn + (1-An) \cdot Xfo) + (1-AR) \cdot Xkb) \quad \cdots (2\text{-}1)$$

$$Y = 1/m \cdot \sum_{n=1}^{m} (AR \cdot (An \cdot Yfn + (1-An) \cdot Yfo) + (1-AR) \cdot Ykb) \quad \cdots (2\text{-}2)$$

$$Z = 1/m \cdot \sum_{n=1}^{m} (AR \cdot (An \cdot Zfn + (1-An) \cdot Zfo) + (1-AR) \cdot Zkb) \quad \cdots (2\text{-}3)$$

[0029] In addition, AR corresponds to the greatest coloring area and shows the effectual screen moment except fields prepared in order to avoid color mixture, such as a black stripe and wiring. Moreover, An supplies a signal to this display and shows the signal equivalent to an area modulation. Moreover, m is the number of coloring matter children which constitutes 1 pixel. The example which calculated the chromaticity of this liquid crystal display based on the example of drawing 1 is shown in drawing 6 .
[0030] That is, he is CIE about the color specification region at this time. L* a* b* It displays on a chromaticity coordinate. Drawing 6 (A) is a* b*. The maximum color difference reappearance region of the liquid crystal display seen from the coordinate is shown, and drawing 6 (B) is L* a*. The maximum lightness reappearance region of the liquid crystal display seen from the coordinate is shown. Now, since it is white (W), the brightest color in a reflective mold electrochromatic display is white brightness lightness L* here. It is the vividness of the color which has, defines as the maximum brightness of a display and can be expressed with a display This a* b* It considers as the area which surrounds the maximum color difference reappearance region by coordinate display.
[0031] It becomes possible by using four sorts of color filters of this example to extend the reappearance region near the achromatic color so that drawing 6 (A) may show. In order for the color filter which makes the conventional red-green blue a fundamental color to realize the same reappearance region, it is necessary to narrow down transparency of each color filter, or reflective bandwidth, and to raise the purity of each color. However, if it does in this way, the use effectiveness of light will fall remarkably.
[0032] Now, generally it is L* a* b*. Although called uniform color space, it seldom has an equal color. For example, it is known that the difference of a color will be sensed near the achromatic color also by the difference in a chromaticity far smaller than the difference in the chromaticity near the high saturation. Although it is not necessarily uniform color space in the NCR color coordinate system currently used by the color order system etc. on the other hand, it is suitable for evaluating the balance of a color, and the color scheme of a color. [many] Now, in this reflective mold electrochromatic display, the graph and color picture in a display screen are expressed with sufficient balance, and let the display sensed comfortable for human being's eyes be a desirable thing. Therefore, it changes into the NCR color coordinate system further here, and the reappearance region of a color is evaluated.
[0033] Drawing 7 (A) is change of the brightness when changing the passband of each color to coincidence. It becomes brighter, as a passband is extended. However, the vividness of a color falls, so that drawing 7 (B) may see and it extends a passband. However, when the image sample from which various vividness and brightness differ was created and the vision experiment was conducted, the result made so desirable [the reappearance capacity of a color] that the product of brightness and vividness is large was obtained. Then, drawing 8 graph-ized the axis of abscissa for the product of brightness and vividness as the passband on the axis of ordinate based on drawing 7 (A) and (B). It is thought most desirable to set up the passband of each color filter before and after about 1-/2 of the passband of a visible region from this drawing. Thereby, brightness can be raised 1.5 times, maintaining vividness. That is, since the passband of the light of each of four colors is before and after 1/2, respectively and the area of each of that color is 1/4, respectively, the use effectiveness of the light of filter 1 color is set to one eighth. Since white is expressed, where four coloring matter

children are turned on, respectively, the use effectiveness of light is set to 4x1/8, and serves as one half of brightness after all. This is 1.5 times the conventional brightness.
[0034] As a result of the display which consists of various color filters with which passbands actually differ based on this result performing swing image display for various conditions and conducting the vision experiment by viewing, vividness was also seldom able to be reduced and the bright most desirable display was able to be constituted [set / of a passband / about 1 / specifically setting the passband of each color filter as the 0.43 to 0.57 times as much range as the bandwidth of a visible region 2 order]. The result of subjectivity evaluation is shown in drawing 9 .
[0035] Drawing 9 is the result of creating the simulation image of the reflective color LCD which used the pass band width and pass band width of a color filter, and performing subjectivity evaluation to the image. Three kinds of images, a female face, fruit, and an alphabetic character and a graph image, were used for subjectivity evaluation. Moreover, the color printer of a film photo method was used for the created simulation image.
[0036] The pass band width of the color filter shown on the axis of abscissa of drawing 9 is the ratio of the pass band width of each filter at the time of setting a visible region (from 400nm to 700nm) to 1, for example, 0.5 is set to 150nm. Moreover, it is an observer's number ratio judged that an axis of ordinate is the range (range judged to be the engine performance which can be equal to use) which can be permitted when subjectivity evaluation is performed. The actually observed number is 14 persons. Consequently, if the pass band width of each filter is the 0.43 to 0.57 times as many range of a visible region as this, the man more than a moiety can call it the range practically judged to be the engine performance which can be equal to use.
[0037] Now, such an electrochromatic display display of 4 color configurations has a quite large color specification region, as drawing 6 (A) explained. However, this is the case where it expresses by all the 4 color-specification signals, and such a large reappearance region is not necessarily attained depending on conversion of three to four chrominance signals. Then, it is desirable to change and express as the most suitable matrix multiplier depending on the field of the color to reproduce. To display 4 chrominance signals YR, CB, LG, and LM, it changes like a degree type (3) and displays.
[0038]
[Equation 3]

$$\begin{bmatrix} YR \\ CB \\ LG \\ LM \end{bmatrix} = \begin{bmatrix} a1 & a2 & a3 \\ b1 & b2 & b3 \\ c1 & c2 & c3 \\ d1 & d2 & d3 \end{bmatrix} \cdot \begin{bmatrix} R \\ C \\ B \end{bmatrix} \quad \cdots(3)$$

[0039] In addition, as a result of experimenting by shaking various matrix multipliers, the result with desirable a1=1, a2=0, a3=0, b1=-1, b2=1, b3=1, c1=0, c2=1, c3=0, d1=0, d2=0, and d3=1 was obtained. At this time, by drawing 4 , delivery and optimal color conversion are performed in the matrix circuit 405, and a multiplier is displayed on it from a graphic controller 403.
[0040] In addition, color conversion may be carried out to this color conversion using not a matrix circuit but table conversion of a three dimension or table conversion, and an interpolation circuit. That is, the table corresponding to display 4 chrominance signals YR, CB, LG, and LM is prepared to a RGB input signal. In this case, although a circuit scale will become large for changing with high precision, unlike conversion by the matrix circuit, it becomes reproducible [all the color space fields expressed with display 4 chrominance signal]. Moreover, since free conversion is attained, natural conversion also becomes possible. The creation approach of the table of a three dimension calculates a chromaticity XYZ first using an upper type (3) to all the combination of display 4 chrominance signals YR, CB, LG, and LM. Next, XYZ which is the chromaticity which RGB which is an input signal expresses is calculated (when the RGB code is prescribed by the NTSC signal which is a standard TV signal, the value is shown in TV handbook.), the thing comrade of the nearest value is made to correspond mutually with the chromaticity XYZ of a possible color by this chromaticity XYZ and 4 color liquid crystal display for which it asked previously, and a table is created.
[0041] In addition, instead of calculating a chromaticity XYZ using an upper type (3), a chromaticity XYZ may be surveyed to all the combination of display 4 chrominance signals YR, CB, LG, and LM with an actual liquid crystal display, and a table may be created similarly. Thus, since the error as which the direction which actually measured and created the table was not considered by count is

taken into consideration, more faithful color specification becomes possible. However, since actually exact and stable measurement may be difficult, it measures to no combination of display 4 chrominance signals YR, CB, LG, and LM, but asks correctly in a specific color, and others can also create a table in quest of the color of a between by interpolation processing etc. By doing in this way, a display becomes possible from matrix conversion, using effectively all the color specification regions of a liquid crystal display.
[0042] Now, a highly minute display is explained below. Drawing 10 (A) shows the usual display mode. That is, when image data 901 is given as an input, a display is displayed like 902 in a display image. However, when the highly minute image data 903 of drawing 10 (B) is inputted, in the highly minute mode, it is displayed like a display image 904. Thus, a twice [about] as many highly minute display as this is attained by displaying.
[0043] That is, to the image data of each twice as many every direction [as this] resolution, it is processed 1 coloring-matter child every, respectively, and is displayed. About four chrominance signals (YR, CB, LG, LM) acquired from RGB3 chrominance signal corresponding to the first pixel, specifically Only YR signal in it is used for an upper left coloring matter child's (YR)'s brightness control, and brightness control of the coloring matter child (CB) to whom only CB signal in it is located in an upper left coloring matter child's (YR)'s right is performed about four chrominance signals (YR, CB, LG, LM) acquired from RGB3 chrominance signal of the following pixel. Such control can be performed using the driver control signal from the timing controller 406 of drawing 4 etc. Thus, by processing 1 coloring-matter child every, brightness resolution can be raised and sufficient color reproduction can be realized for human being's vision on the average.
[0044] However, since it has the relation of the complementary color into level next doors by arrangement of this color, even if a high definition image is inputted perpendicularly, there is almost no change of the color in the edge section. However, like a horizontally high definition image and a display image 904, in the display of the slanting edge section, a part of color specification may be missing, and a color blot may arise in the edge section. However, a highly minute display is attained from the normal mode of drawing 9 (A).
[0045] Now, when expressing the edge section with high definition in this way, depending on the direction of an edge, a color will change in the edge section somewhat. then, the case where a chromaticity is calculated by the 2x2 coloring-matter child, and it cannot reappear within a 2x2 coloring-matter child in consideration of the color specification between the pixels which adjoined in order to mitigate change of this color -- that error -- a contiguity pixel -- spreading -- more -- highly minute -- in addition -- and it becomes possible by taking the configuration of drawing 11 to press down fluctuation of the color in the edge section including a circumference pixel.
[0046] Drawing 11 is equivalent to the matrix circuit 405 of drawing 4 . The input picture signal RGB 1001 is inputted and it is changed into four chrominance signals YR, CB, LG, and LM through an adder 1002 in the matrix circuit 1003. Next, four colors each are changed and outputted to a liquid crystal display coloring matter child's number of gradation which can be expressed with a quantizer 1004. In addition, the matrix circuit 1003 and a quantizer 1004 may be transposed to one table 1005, and may be constituted. Four chrominance signals outputted to the liquid crystal display coloring matter child on the other hand are inputted into the block 1006 which performs a 2x2 coloring-matter child's chromaticity count. The chromaticity count block 1006 has composition containing a line buffer, records the information on front Rhine, and calculates the value of the color in a 2x2 coloring-matter child including the coloring matter child processed now.
[0047] Although the count approach is the same as that of how to calculate XYZ described previously fundamentally, since an input is an RGB code here, it becomes that to calculate by RGB is more advantageous. What is necessary is just to use a rgb stimulus value instead of a tristimulus value xyz for calculating by RGB. Moreover, it displays in fact in the combination in which an expression by four colors is possible, the colorimetry of the displayed color is carried out by RGB data, the value is recorded on a table, and the approach of changing is practical. For example, when each color 16 level display is possible, RGB each color output of 8 bits then, and RGB each color correspondence of 8 bits by 196 K bytes are attained in a 16-bit input. In addition, a color specification possible field spreads rather than this gentleman changes into four chrominance signals in the matrix circuit 1003. Now, it does in this way and the error of a 2x2 coloring-matter child's

chromaticity and an input RGB code is calculated for RGB each color of every in a difference circuit 107. This error is inputted into the error buffer 1008. Drawing 12 shows signs that the error is diffused in surroundings ABCD of the pixel "X" currently processed. It may be referred to as A=B=C=D=1/4 in order to simplify a circuit as a multiplier which diffuses this error, and you may distribute equally to each pixel. In this case, a multiplier becomes unnecessary, only chooses 6 bits from a high order, and should just add them. The diffusion coefficient multiplication circuit 1009 consists of such a circuit. That is, in the diffusion coefficient multiplication circuit 1009, the multiplication of the predetermined diffusion coefficient is carried out to an error value, and the error correction data diffused in a circumference pixel are called for. Error correction data are added with an adder 1002, and input image data is amended by this.

[0048] Color specification becomes possible by the circumference pixel also by the color which cannot be expressed by the independent 2x2 coloring-matter child by this loop formation. That is, in order that a loop formation may work so that the average color difference may be set to 0 by this processing, average color specification is in agreement with the color of an input signal.

[0049] In addition, since it works so that the error of a big color may be made small in reproducing the color clearly beyond the color specification region of the electrochromatic display in this example, the color picture display from which balance shifted to the whole by the case may be made. Then, in such a case, it is not indicated by drawing 11 , but the reappearance region translation table changed between the input image data 1001 and an adder 1002 in the color reappearance region of this example is arranged, it changes into the signal of the reappearance range, and it becomes possible to mitigate the bias of color specification balance by guaranteeing average color specification. Moreover, in a display with such a color display, it is required in many cases that the brightness display should be correctly displayed rather than color specification nature. With such a case, he is CIE about control foreground-color space. L* a* b* When it changes into brightness color-difference signals, such as chromaticity space, weight is made [many] at the error of brightness, and correspondence becomes possible by carrying out processing of making weight small to a color-difference signal.

[0050] That is, he is CIE from an RGB code about input image data at drawing 11 . L* a* b* It changes into a signal. Moreover, the output of the block 1006 which performs a 2x2 coloring-matter child's chromaticity count is also CIE. L* a* b* Rather than color specification nature, the brightness display will be correctly displayed by changing into a signal and considering as the multiplier of brightness priority depending on how choosing the multiplier in the error diffusion coefficient multiplication circuit 1009. Even if the chrominance signal which is in the outside of a color specification region somewhat by doing in this way is inputted, a luminance signal is not saturated and the bias of extreme balance decreases.

[0051] In this example, arrangement of the color of four colors is arranged, as it has a complementary color relation to a display horizontal direction. Generally a Japanese display requires resolution perpendicularly in many cases (the inclination exists also with an alphabetic character). Moreover, as a high definition alphabetic character, monochrome alphabetic character has more highly minute displays than a color alphabetic character. Then, by arranging in this way, even if it performs an achromatic color display perpendicularly and displays for every 1 coloring-matter child, a blot of a color decreases on an edge and an achromatic color display is attained.

[0052] Moreover, in this example, since it is expressing by four colors of 2x2, it becomes easy to maintain the breadth of color specification and its balance in a color space comparatively rather than three chrominance signals. That is, it is easy to become a color specification region long and slender in the green direction or the purple direction like [in 3 later mentioned, for example although there is breadth of a color with comparatively sufficient balance like drawing 6 (A) in order for four points to prescribe by four colors to three points prescribing the breadth of a color space by three colors colors] drawing 18 (A). Therefore, the reappearance region near [some] the achromatic color may become narrow. Generally, since sensibility is high, when the reappearance region near the achromatic color is narrow, as for the color near the achromatic color, unnaturalness may be visually conspicuous. However, when four points prescribe a color space, there are the descriptions, like it becomes easy to extend the color specification such near the achromatic color comparatively. Moreover, on a vision property, comparatively, to the saturation direction, since the allowed value is

large, it approves also with the image output of to some extent low saturation. Thus, when it expresses as four colors, the degree of freedom of a design of the reappearance range of a color also has an advantage, like increase and an optimum design become easy. Moreover, since passage of each coloring matter child or a reflective band seldom serves as a ** band, selection of actual coloring matter etc. also becomes easy. Moreover, a highly minute display is attained by controlling brightness by one pigment unit, as stated previously. Although the error of the color in an edge arises somewhat at this time, since the sensibility of a color falls, for a certain reason, with a highly minute edge, the highly minute display also of a hardly worrisome property is visually attained in sufficient precision practical.

[0053] (The 2nd example) This example explains the color liquid crystal display of the combination mold in the mode used with a reflective mold, and the mode used with a transparency mold. Although the fundamental liquid crystal display part is the same as that of drawing 3 , in this example, it has the back light. That is, back light optical system is constituted by the light source 1201 and the light guide plate 1202, when outdoor daylight is bright, it is used as a usual reflective mold display and outdoor daylight has been lost, the light source 1201 is turned on, and it is used as a transparency mold as shown in drawing 13 . In addition, the fluorescent lamp with which reinforcement becomes strong near the main wavelength of each color filter 301 as the light source 1201 is desirable. For example, in the example in the quadrisection mentioned above, a four-wave type fluorescent lamp is desirable. Moreover, in reflective mode, light reflects and a reflecting plate 1203 consists of an opaque white color plate which has the function to pass the light of back light optical system by the transparent mode. In addition, a reflection property may be given to a light guide plate 1202.

[0054] Moreover, color specification differs in reflective mode and the transparent mode. Then, in order to lessen the difference in this color specification, it is desirable to change and to supply the multiplier of the matrix supplied to the matrix circuit 405 in the drive system of drawing 4 according to the mode, so that it may be suitable for each. Thereby, different color conversion according to the mode can be performed. Moreover, although not indicated by drawing 13 , it is desirable to measure the illuminance (outdoor daylight) in a liquid crystal panel side by the sensor, and to carry out adjustable [of the quantity of light of the light source 1201] according to the illuminance, and to carry out adjustable [of the multiplier of the matrix circuit 405] according to the quantity of light of the light source. Thereby, different color conversion according to the quantity of light of the light source can be performed. In addition, about how to decide a matrix multiplier, the specific color at this time is expressed a reflective mode ** table supposing standard outdoor daylight (for example, D65 etc.), for example, eight colors and 27 colors are displayed, it measures by the colorimeter, and this value is decided to be desired value. Next, the light source is turned on, the same signal as the time of the reflective mode at the time of each quantity of light is given, a specific color is displayed, it measures by the colorimeter, and the multiplier of a matrix is determined that this measured value will turn into desired value decided previously for example, by a least square error method etc. What is necessary is just to control by memorizing the multiplier of the matrix at this time.

[0055] In addition, although this example explained the combination type of reflection and transparency, you may use it as only for transparency. In this case, a color picture with contrast with it more sufficient [to use the liquid crystal in TN mode as liquid crystal] is obtained. However, since a polarizing plate will be used in this case, brightness decreases. However, as compared with the liquid crystal display which consists of the usual RGB filter, one about 1.5 times the brightness of this is obtained. Conversely, if it says, the quantity of light needed for a back light can be managed with about 0.67 times, and power-saving will be made.

[0056] (The 3rd example) This example explains a trichotomy type liquid crystal display. Although the use effectiveness of light falls according to the number of partitions by the method which divides 1 pixel, if the bandwidth of the light which the color component each divided penetrates is extended, brightness will improve. However, when it extends the twice of the pass band width of R, G, and B simply like Y, M, and C, saturation will fall. Drawing 14 is the example of the transparency at the time of making it the pass band width of each color filter become half [of a visible region], or the reflective spectral characteristic, when the number of partitions is 3. That is, for 470 to 620nm, as for transparency and the blue system color filter 1302, 670 to 700nm is [the green system color filter

1301 / 580 to 700nm of transparency and the red system color filter 1303] transparency. [400 to 520nm and] [400 to 430nm and]
[0057] In addition, the property which served as the color filter may be given to the liquid crystal itself instead of a color filter. As for this, the same is said of the quadrisection type thing of the 1st example. What explained the liquid crystal itself in the column of a Prior art as the technique of giving color specification nature, for example, uses the birefringence effectiveness can be used without using a color filter.
[0058] Drawing 15 is arrangement of each color filter. Drawing 16 is CIE about the color specification region when using this color filter. L* a* b* It displays on a chromaticity coordinate. Drawing 16 (A) is a* b*. The maximum color difference reappearance region of the liquid crystal display seen from the coordinate is shown, and drawing 16 (B) is L* a*. The maximum lightness reappearance region of the liquid crystal display seen from the coordinate is shown. Also in this case, as the previous example explained, brightness improves and, moreover, little display of a fall of saturation is attained. That is, brightness, the product of vividness, and the relation of a pass-band-width region show the same inclination as drawing 8 . In addition, in the color filter in this example, although white is slight, it is a yellow twist.
[0059] Drawing 17 is the spectral characteristic of the color filter which has improved white balance. That is, for 490 to 570nm, as for transparency and the blue system color filter 1602, 630 to 700nm is [the green system color filter 1601 / 580 to 700nm of transparency and the red system color filter 1603] transparency. [400 to 510nm and] [400 to 430nm and] Drawing 18 is CIE about the color specification region when using this color filter. L* a* b* It displays on a chromaticity coordinate. Drawing 18 (A) is a* b*. The maximum color difference reappearance region of the liquid crystal display seen from the coordinate is shown, and drawing 18 (B) is L* a*. The maximum lightness reappearance region of the liquid crystal display seen from the coordinate is shown.
[0060] When it is made for the passage bandwidth of each color filter to become the range which is 0.43 to 0.57 times the bandwidth of the about 1-/2 order of a visible region, i.e., a visible region, in this way, brightness of all improves 1.5 times, and the fall of vividness is settled in the range which is not worried comparatively, and has a property good as a electrochromatic display.
[0061] (The 4th example) This example is an example in the application which thought brightness as important. In the example of drawing 1 , each coloring matter child's transparency or reflective band quadrisected the visible region, respectively, and had the passband for two divided. In this case, as explained previously, although it explains that the well-balanced good property is acquired [the vividness of a color] also for brightness, depending on an application, brightness may be required further. For example, are the filter of a yellowy red color system as a filter 101, and about 700nm penetrates from the wavelength of about 520nm. As a filter 102, are the filter of a copper rust color system, and about 580nm penetrates from the wavelength of about 400nm. As a filter 103, it is a green system, and if 650nm uses the thing of transparency, and about 400nm wavelength to 490 nm and the about 610nm - 700 nm transparency as a filter 104 by the Magenta color system from the wavelength of about 460nm, as compared with the 1st example, brightness will increase about 25%. If a passband is furthermore extended and a part for three band is made into a passband among quadrisection of a visible region, as compared with the 1st example, brightness will increase about 50%. Although the vividness of the color which can be displayed, of course falls, it is suitable for the purpose which displays vividly more brightly. In addition, such technique is applicable also to the color display of the trichotomy type seen not only in the color display system of quadrisection but in the 3rd example.
[0062]
[Effect of the Invention] As explained above, according to this invention, the available quantity of light in each coloring matter child can be raised to abbreviation 3/2 by carrying out each coloring matter child's divided transparency, or reflective bandwidth before and after 1/2 of a visible region, respectively. Moreover, the reappearance range of the important color of low saturation is enough secured to coincidence on vision by 4 color control, and reservation of the balance of the color specification near the achromatic color becomes easy. Moreover, there is comparatively little effect in the color of high saturation seldom worried on vision. It becomes possible to constitute a reflective mold display from doing in this way, and it becomes possible to constitute the

electrochromatic display which fitted equipment with the demand of power-saving higher than the precision of color specification like the pocket device.

[0063] Moreover, while a twice [about] as many highly precise display as the resolution of the coloring matter child who constitutes 1 pixel from controlling the brightness control in each coloring matter child for every 1 coloring-matter child, i.e., a pixel, is attained, it becomes possible to suppress the color blot by the edge in such a display.

[0064] Moreover, optimal color specification is made possible by performing color conversion on the matrix conversion or the table of a multiplier which changes with color specification range expressed, or performing color conversion which displays further using transparency and the reflected light, and is different according to outdoor daylight etc.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Generally, color picture displays, such as a color CRT display and a color liquid crystal display, are additive-mixture-of-colors displays, and a display is performed based on the three primary colors of red (R), green (G), and blue (B). Moreover, in the subtractive-color-mixture display of a color printer etc., the display is performed cyanogen (C), a Magenta (M), and based on the three primary colors of yellow (Y).
[0003] In the typical color liquid crystal display, it is trichotomized and 1 pixel of color filters with which a fundamental color consists of combination of three colors of red-green blue is used. However, if n division of 1 pixel is done in this way and the passband of the light in each divided field is also made into each number of partitions, white brightness will be set to 1 for the number of partitions when it expresses it with the sum of the fundamental color which constitutes a pixel also for expressing white, for example. That is, in trichotomy, the passband of the light in the each divided fundamental color is set to one third, respectively, and since the area of each of that color is 1/3, respectively, the use effectiveness of the light of filter 1 color is set to one ninth after all.
[0004] Since white is expressed and three fundamental colors are turned on now, respectively, the use effectiveness of light is set to 3x1/9, and serves as one third of brightness after all. Therefore, in such a color filter, even when displaying the white which is the brightest color, only use of one third of light can be performed. Therefore, in the reflective mold display of such a configuration, since it becomes dark, there is a fault of vividness also falling.
[0005] Moreover, if the configuration from which brightness sufficient in a transparency mold for a back light is obtained is taken, the skillful color specification also of such a configuration will become possible, but on the other hand a fault -- much power is needed for a back light drive -- arises. Moreover, in expressing 1 pixel with the component of two or more colors, in order to obtain the same resolution, it needed to manufacture with high definition only the two or more times, and there was un-arranging -- the manufacture becomes difficult -- on the relation of the yield.
[0006] So, recently, the liquid crystal display which carries out color display without using a color filter is devised (Nikkei micro device January issue 1994 P99). With this equipment, in carrying out a color expression, it changes the electrical potential difference applied to liquid crystal using the form birefringence of liquid crystal, and the color is expressed by making the birefringence effectiveness adjustable. However, although the difference in a color is controllable by this approach, since a gradation display is difficult, a free color expression cannot be performed.
[0007] Moreover, 1 pixel is divided into two and the reflective mold liquid crystal display with which each fundamental color used cyanogen and the color filter of Orange is known (Institute of Electronics, Information and Communication Engineers Vol. 77 No.3 pp.296-303 March, 1994). However, the expression only of the color of the color specification field on the flat surface to which two colors which are fundamental colors are connected with this approach was completed, but the full color expression was difficult for it.
[0008] Moreover, there is also an idea of saying that color specification is performed by the lap of a color like printing ("next-generation liquid crystal display technical" Tatsuo Uchida Kogyo Chosakai Publishing publication (November 1, 1994) p172 written by editing reflective mold color LCD). However, since it is necessary to manufacture a liquid crystal panel in fact [in order to realize this method] in a laminating, the thickness in the layer of each color arises, and when it observes from across, there are problems, like the parallax of three colors arises. Furthermore, if it inquired in a

detail, since the liquid crystal panel of three colors would lap, many reflectors in each class existed and, for a certain reason, the loss of the light in each class also had the problem of becoming [the liquid crystal display panel of a monolayer], and becoming the display of a dark image further.

[Translation done.]

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[Translation done.]

EFFECT OF THE INVENTION

[Effect of the Invention] As explained above, according to this invention, the available quantity of light in each coloring matter child can be raised to abbreviation 3/2 by carrying out each coloring matter child's divided transparency, or reflective bandwidth before and after 1/2 of a visible region, respectively. Moreover, the reappearance range of the important color of low saturation is enough secured to coincidence on vision by 4 color control, and reservation of the balance of the color specification near the achromatic color becomes easy. Moreover, there is comparatively little effect in the color of high saturation seldom worried on vision. It becomes possible to constitute a reflective mold display from doing in this way, and it becomes possible to constitute the electrochromatic display which fitted equipment with the demand of power-saving higher than the precision of color specification like the pocket device.
[0063] Moreover, while a twice [about] as many highly precise display as the resolution of the coloring matter child who constitutes 1 pixel from controlling the brightness control in each coloring matter child for every 1 coloring-matter child, i.e., a pixel, is attained, it becomes possible to suppress the color blot by the edge in such a display.
[0064] Moreover, optimal color specification is made possible by performing color conversion on the matrix conversion or the table of a multiplier which changes with color specification range expressed, or performing color conversion which displays further using transparency and the reflected light, and is different according to outdoor daylight etc.

[Translation done.]

MEANS

[Means for Solving the Problem] In order to attain the purpose mentioned above, 1 pixel is constituted from three or more coloring matter children, each coloring matter child has spectral distribution different, respectively, and the color picture display of this invention is characterized by making bandwidth of passage or reflection into the value within the limits of 0.43 to 0.57 times of the bandwidth of a visible region by each coloring matter child's spectral distribution, respectively.
[0012] Moreover, it is the color picture display of this invention constituting 1 pixel from four coloring matter children, piling up mutually passage of each coloring matter child or a reflective band in part in each coloring matter child's spectral characteristic, and making each coloring matter child's bandwidth into a comparable value further, and brightly, there are few saturation falls and they are characterized by enabling reappearance of the white of an achromatic color further mostly.
[0013] Moreover, the color picture display of this invention is set to the color picture display with which 1 pixel consists of the 1st thru/or 4th four coloring matter child. The band of the passage or reflection in said 1st thru/or 4th coloring matter child's spectral characteristic It is characterized by making it 700nm from 480nm and about 630nm from 630nm from about 550nm from the wavelength of about 400nm, about 700nm from the wavelength of about 550nm, and the wavelength of about 480nm, and the wavelength of about 400nm, respectively.
[0014] Moreover, the color picture display of this invention makes arrangement of 4 coloring-matter child who constitutes each pixel a vertical 2 coloring-matter child and the horizontal coloring matter child 2, changes color three-primary-colors display-image data into four chrominance signals corresponding to said 4 coloring-matter child, and is characterized by providing the means which carries out brightness control of said 4 coloring-matter child for every coloring matter child. Moreover, in case it changes and displays on four chrominance signals from color three-primary-colors display-image data, it is desirable to perform color conversion on the matrix conversion or the table of a multiplier which changes with color specification range expressed. Furthermore, the repeatability of the foreground color in a highly minute display is improvable by evaluating an error with the chromaticity of input image data with four adjoining coloring matter, and establishing a means to add amendment to the brightness control of the coloring matter child who adjoins according to the chromaticity error. moreover, the thing arranged as the coloring matter children arranged horizontally have a complementary color relation mostly, when arrangement of 4 coloring-matter child is made into a vertical 2 coloring-matter child and the horizontal coloring matter child 2 -- ** -- it is desirable.
[0015] Moreover, this invention is set to the color picture display of the concomitant use mold which can change the transparent mode mold displayed using the transmitted light, the reflective mode type displayed using the reflected light or these transparency, and reflective mode. It is characterized by providing a means to generate four chrominance signals corresponding to said 4 coloring-matter child from color three-primary-colors display-image data by constituting 1 pixel from four coloring matter children, and performing different color conversion according to the display mode or outdoor daylight of said color picture display.
[0016] Moreover, two or more liquid crystal cells by which this invention has been arranged in the shape of a matrix in the color liquid crystal display, It is the color filter arranged on each pixel which consists of four liquid crystal cells which adjoined mutually two every direction at a time, and have been arranged. The color filter of four colors which have mutually different spectral distribution and

have a value within the limits whose bandwidth of the passage or reflection in the spectral distribution of each color filter is 0.43 to 0.57 times the bandwidth of a visible region, respectively, It is characterized by constituting from a means to change and output color three-primary-colors display-image data to four chrominance signals corresponding to the color filter of said four colors.
[0017] furthermore, in realizing the color liquid crystal display which trichotomizes 1 pixel and uses the color filter of three colors In order to raise the use effectiveness of light, 470 to 620nm penetrates a green system color filter. 670 to 700nm penetrates a blue system color filter. [400 to 520nm and] [whether a red system color filter uses the color filter characterized by 580 to 700nm consisting of transparency, and] [400 to 430nm and] Or 490 to 570nm penetrates a green system color filter, and 630 to 700nm penetrates transparency and a blue system color filter. [400 to 510nm and] As for a red system color filter, it is desirable to use the color filter with which 580 to 700nm consists of transparency. [400 to 430nm and]

[Translation done.]

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OPERATION

[Function] The available quantity of light in each coloring matter child can be raised about 3 / twice by making each coloring matter child's divided transparency, or reflective bandwidth into the value before and behind 1/2 of a visible region (i.e., within the limits of 0.43 to 0.57 times of the bandwidth of a visible region), respectively. Moreover, by controlling four colors to coincidence, the reappearance range of the important color of low saturation can be enough secured now on vision, and reservation of the balance of the color specification near the achromatic color becomes easy. Moreover, there is comparatively little effect in the color of high saturation seldom worried on vision. Moreover, while a twice [about] as many highly precise display as the resolution of the coloring matter child who constitutes 1 pixel from controlling the brightness control in each coloring matter child for every 1 coloring-matter child, i.e., a pixel, is attained, it becomes possible to suppress the color blot by the edge of such a display.

[Translation done.]

EXAMPLE

[Example] Hereafter, the example of this invention is explained with reference to a drawing.
(Example 1) Drawing 1 is drawing showing the quadrisection type spectral characteristic of the electrochromatic display concerning this example. In this drawing, a filter 101 is a filter of a yellowy red color system (YR), and about 700nm penetrates it from the wavelength of about 550nm. A filter 102 is a filter of a copper rust color system (CB), and about 550nm penetrates it from the wavelength of about 400nm. A filter 103 is a filter of a green system (LG), 630nm of transparency and a filter 104 is the filter of a Magenta color system (LM) from the wavelength of about 480nm, and about 400nm wavelength to 480 nm and about 630nm - 700 nm are transparency. Although this drawing shows the spectral characteristic of an ideal color filter, a metaphor has a thing corresponding to the ZENRACHIN color filter made from KODAKKU in realizing mostly.
[0020] for example, the filter 101 -- KODAKKURATTEN gelatin filter NO.15 and a filter 102 -- this NO.47A and a filter 103 -- said -- NO.40 and a filter 104 -- said -- it is realizable by NO.30 etc.
[0021] Moreover, drawing 2 is drawing which has arranged spatially the four above-mentioned sorts of color filters. Here, 1 pixel, it consists of four components corresponding to four kinds of colors, and this is called 1 pixel. Moreover, the component of each color will be called a coloring matter child. Drawing 3 is the example constituted as a reflective mold liquid crystal panel. A color filter 301 is divided superficially and arranged by the black matrix 302. That is, drawing 2 serves as drawing which looked at the reflective mold liquid crystal panel from the upper part, and drawing 3 shows the sectional view. In this case, four sorts of color filters of drawing 2 will be arranged on four liquid crystal cells which constitute 1 pixel.
[0022] Now, in drawing 3 , the transparent electrode 303 has been arranged at the liquid crystal side of a color filter 301, and the liquid crystal layer 305 is pinched with the counterelectrode (reflecting plate electrode) 304 which serves as a reflecting plate. In the reflective mold LCD, the phase transition mold guest host method which does not use a polarizing plate as liquid crystal is suitable from ****** with the need of if possible raising the use effectiveness of light. The reflecting plate electrode 304 is connected to TFT306, and the liquid crystal layer 305 is divided into two or more liquid crystal cells by which matrix arrangement was carried out by these reflecting plate electrode 304 and TFT306. A color picture is displayed because only the liquid crystal cell section chosen by TFT306 reflects or absorbs colored light.
[0023] Drawing 4 shows the example which uses this reflective mold liquid crystal panel as a display monitor of a personal computer. Image data is emitted from CPU401, is supplied to a graphic controller 403 through a bus 402, and is written in a frame memory 404. The image data written in the frame memory 404 is changed into four chrominance signals for liquid crystal displays (YR, CB, LG, LM) from RGB3 chrominance signal by the matrix circuit 405. These four chrominance signals are sent to the timing controller 406, are doubled with a horizontal/vertical synchronizing signal from a graphic controller 403, and are sent to the gradation electrical-potential-difference generating section 407. In the gradation electrical-potential-difference generating section 407, each chrominance signal of four chrominance signals is changed into the electrical potential difference of a multiple value, and it is supplied to a liquid crystal panel 409 through the source driver 408. Moreover, an electrical potential difference is supplied to the color pixel of the position of a liquid crystal panel 409 by work of a gate driver 410 and the source driver 408 at this time, brightness control is made by this for every color of YR, CB, LG, and LM, and a predetermined color is

reproduced.
[0024] Now, the color specification nature of the liquid crystal display displayed by doing in this way is explained. Drawing 5 is a part of drawing 2 , and examines the model of liquid crystal with the juxtaposition color mixture model of the black matrix 501, the reflective part 502 of a color filter, and the absorption part 503. A strict examination is enough as it for practical examination in the case where an observation post examines a color specification region at the front of a panel, although such a model cannot describe the color specification of liquid crystal.
[0025] Now, the spectral characteristic of the color filter 101 of a yellowy red color system is set to Fy (r), and it asks for the chromaticities Xfy, Yfy, and Zfy by degree type (1-1) - (1-3). Here, S (r) is the light source for observation, or a source of the illumination light. X (r), Y (r), and Z (r) are the spectral characteristics of a tristimulus value.
[0026]
[Equation 1]

$$Xfy=\int_r S(r)\,Fy(r)\,X(r)\,d_r \Big/ \int_r S(r)\,Y(r)\,d_r \quad \cdots(1\text{-}1)$$

$$Yfy=\int_r S(r)\,Fy(r)\,Y(r)\,d_r \Big/ \int_r S(r)\,Y(r)\,d_r \quad \cdots(1\text{-}2)$$

$$Zfy=\int_r S(r)\,Fy(r)\,Z(r)\,d_r \Big/ \int_r S(r)\,Y(r)\,d_r \quad \cdots(1\text{-}3)$$

[0027] Similarly, the spectral characteristic of the filter 102 of a copper rust color system is set to Fc (r), and it asks for the chromaticities Xfc, Yfc, and Zfc. Moreover, it asks for the chromaticities Xfg, Yfg, and Zfg of the green system filter 103, and the chromaticities Xfm, Yfm, and Zfm of the Magenta color system filter 104. Similarly, the color of black matrix 501 part to avoid color mixture is asked for the chromaticities Xfo, Yfo, and Zfo at the time of Xkb, Ykb, Zkb, and OFF of each color filter. In addition, the spectral characteristic of the liquid crystal itself is included in a color filter here, and is examined. It can ask for the chromaticities X, Y, and Z of a display by degree type (2-1) - (2-3) from the model of juxtaposition color mixture.
[0028]
[Equation 2]

$$X=1/m\cdot\sum_{n=1}^{m}(AR\cdot(An\cdot Xfn+(1-An)\cdot Xfo)+(1-AR)\cdot Xkb) \quad \cdots(2\text{-}1)$$

$$Y=1/m\cdot\sum_{n=1}^{m}(AR\cdot(An\cdot Yfn+(1-An)\cdot Yfo)+(1-AR)\cdot Ykb) \quad \cdots(2\text{-}2)$$

$$Z=1/m\cdot\sum_{n=1}^{m}(AR\cdot(An\cdot Zfn+(1-An)\cdot Zfo)+(1-AR)\cdot Zkb) \quad \cdots(2\text{-}3)$$

[0029] In addition, AR corresponds to the greatest coloring area and shows the effectual screen moment except fields prepared in order to avoid color mixture, such as a black stripe and wiring. Moreover, An supplies a signal to this display and shows the signal equivalent to an area modulation. Moreover, m is the number of coloring matter children which constitutes 1 pixel. The example which calculated the chromaticity of this liquid crystal display based on the example of drawing 1 is shown in drawing 6 .
[0030] That is, he is CIE about the color specification region at this time. L* a* b* It displays on a chromaticity coordinate. Drawing 6 (A) is a* b*. The maximum color difference reappearance region of the liquid crystal display seen from the coordinate is shown, and drawing 6 (B) is L* a*. The maximum lightness reappearance region of the liquid crystal display seen from the coordinate is shown. Now, since it is white (W), the brightest color in a reflective mold electrochromatic display is white brightness lightness L* here. It is the vividness of the color which has, defines as the maximum brightness of a display and can be expressed with a display This a* b* It considers as the area which surrounds the maximum color difference reappearance region by coordinate display.

[0031] It becomes possible by using four sorts of color filters of this example to extend the reappearance region near the achromatic color so that drawing 6 (A) may show. In order for the color filter which makes the conventional red-green blue a fundamental color to realize the same reappearance region, it is necessary to narrow down transparency of each color filter, or reflective bandwidth, and to raise the purity of each color. However, if it does in this way, the use effectiveness of light will fall remarkably.
[0032] Now, generally it is L* a* b*. Although called uniform color space, it seldom has an equal color. For example, it is known that the difference of a color will be sensed near the achromatic color also by the difference in a chromaticity far smaller than the difference in the chromaticity near the high saturation. Although it is not necessarily uniform color space in the NCR color coordinate system currently used by the color order system etc. on the other hand, it is suitable for evaluating the balance of a color, and the color scheme of a color. [many] Now, in this reflective mold electrochromatic display, the graph and color picture in a display screen are expressed with sufficient balance, and let the display sensed comfortable for human being's eyes be a desirable thing. Therefore, it changes into the NCR color coordinate system further here, and the reappearance region of a color is evaluated.
[0033] Drawing 7 (A) is change of the brightness when changing the passband of each color to coincidence. It becomes brighter, as a passband is extended. However, the vividness of a color falls, so that drawing 7 (B) may see and it extends a passband. However, when the image sample from which various vividness and brightness differ was created and the vision experiment was conducted, the result made so desirable [the reappearance capacity of a color] that the product of brightness and vividness is large was obtained. Then, drawing 8 graph-ized the axis of abscissa for the product of brightness and vividness as the passband on the axis of ordinate based on drawing 7 (A) and (B). It is thought most desirable to set up the passband of each color filter before and after about 1-/2 of the passband of a visible region from this drawing. Thereby, brightness can be raised 1.5 times, maintaining vividness. That is, since the passband of the light of each of four colors is before and after 1/2, respectively and the area of each of that color is 1/4, respectively, the use effectiveness of the light of filter 1 color is set to one eighth. Since white is expressed, where four coloring matter children are turned on, respectively, the use effectiveness of light is set to 4x1/8, and serves as one half of brightness after all. This is 1.5 times the conventional brightness.
[0034] As a result of the display which consists of various color filters with which passbands actually differ based on this result performing swing image display for various conditions and conducting the vision experiment by viewing, vividness was also seldom able to be reduced and the bright most desirable display was able to be constituted [set / of a passband / about 1 / specifically setting the passband of each color filter as the 0.43 to 0.57 times as much range as the bandwidth of a visible region 2 order]. The result of subjectivity evaluation is shown in drawing 9 .
[0035] Drawing 9 is the result of creating the simulation image of the reflective color LCD which used the pass band width and pass band width of a color filter, and performing subjectivity evaluation to the image. Three kinds of images, a female face, fruit, and an alphabetic character and a graph image, were used for subjectivity evaluation. Moreover, the color printer of a film photo method was used for the created simulation image.
[0036] The pass band width of the color filter shown on the axis of abscissa of drawing 9 is the ratio of the pass band width of each filter at the time of setting a visible region (from 400nm to 700nm) to 1, for example, 0.5 is set to 150nm. Moreover, it is an observer's number ratio judged that an axis of ordinate is the range (range judged to be the engine performance which can be equal to use) which can be permitted when subjectivity evaluation is performed. The actually observed number is 14 persons. Consequently, if the pass band width of each filter is the 0.43 to 0.57 times as many range of a visible region as this, the man more than a moiety can call it the range practically judged to be the engine performance which can be equal to use.
[0037] Now, such an electrochromatic display display of 4 color configurations has a quite large color specification region, as drawing 6 (A) explained. However, this is the case where it expresses by all the 4 color-specification signals, and such a large reappearance region is not necessarily attained depending on conversion of three to four chrominance signals. Then, it is desirable to change and express as the most suitable matrix multiplier depending on the field of the color to

reproduce. To display 4 chrominance signals YR, CB, LG, and LM, it changes like a degree type (3) and displays.

[0038]

[Equation 3]

$$\begin{pmatrix} YR \\ CB \\ LG \\ LM \end{pmatrix} = \begin{pmatrix} a1 & a2 & a3 \\ b1 & b2 & b3 \\ c1 & c2 & c3 \\ d1 & d2 & d3 \end{pmatrix} \cdot \begin{pmatrix} R \\ C \\ B \end{pmatrix} \quad \cdots (3)$$

[0039] In addition, as a result of experimenting by shaking various matrix multipliers, the result with desirable a1=1, a2=0, a3=0, b1=-1, b2=1, b3=1, c1=0, c2=1, c3=0, d1=0, d2=0, and d3=1 was obtained. At this time, by drawing 4 , delivery and optimal color conversion are performed in the matrix circuit 405, and a multiplier is displayed on it from a graphic controller 403.

[0040] In addition, color conversion may be carried out to this color conversion using not a matrix circuit but table conversion of a three dimension or table conversion, and an interpolation circuit. That is, the table corresponding to display 4 chrominance signals YR, CB, LG, and LM is prepared to a RGB input signal. In this case, although a circuit scale will become large for changing with high precision, unlike conversion by the matrix circuit, it becomes reproducible [all the color space fields expressed with display 4 chrominance signal]. Moreover, since free conversion is attained, natural conversion also becomes possible. The creation approach of the table of a three dimension calculates a chromaticity XYZ first using an upper type (3) to all the combination of display 4 chrominance signals YR, CB, LG, and LM. Next, XYZ which is the chromaticity which RGB which is an input signal expresses is calculated (when the RGB code is prescribed by the NTSC signal which is a standard TV signal, the value is shown in TV handbook.), the thing comrade of the nearest value is made to correspond mutually with the chromaticity XYZ of a possible color by this chromaticity XYZ and 4 color liquid crystal display for which it asked previously, and a table is created.

[0041] In addition, instead of calculating a chromaticity XYZ using an upper type (3), a chromaticity XYZ may be surveyed to all the combination of display 4 chrominance signals YR, CB, LG, and LM with an actual liquid crystal display, and a table may be created similarly. Thus, since the error as which the direction which actually measured and created the table was not considered by count is taken into consideration, more faithful color specification becomes possible. However, since actually exact and stable measurement may be difficult, it measures to no combination of display 4 chrominance signals YR, CB, LG, and LM, but asks correctly in a specific color, and others can also create a table in quest of the color of a between by interpolation processing etc. By doing in this way, a display becomes possible from matrix conversion, using effectively all the color specification regions of a liquid crystal display.

[0042] Now, a highly minute display is explained below. Drawing 10 (A) shows the usual display mode. That is, when image data 901 is given as an input, a display is displayed like 902 in a display image. However, when the highly minute image data 903 of drawing 10 (B) is inputted, in the highly minute mode, it is displayed like a display image 904. Thus, a twice [about] as many highly minute display as this is attained by displaying.

[0043] That is, to the image data of each twice as many every direction [as this] resolution, it is processed 1 coloring-matter child every, respectively, and is displayed. About four chrominance signals (YR, CB, LG, LM) acquired from RGB3 chrominance signal corresponding to the first pixel, specifically Only YR signal in it is used for an upper left coloring matter child's (YR)'s brightness control, and brightness control of the coloring matter child (CB) to whom only CB signal in it is located in an upper left coloring matter child's (YR)'s right is performed about four chrominance signals (YR, CB, LG, LM) acquired from RGB3 chrominance signal of the following pixel. Such control can be performed using the driver control signal from the timing controller 406 of drawing 4 etc. Thus, by processing 1 coloring-matter child every, brightness resolution can be raised and sufficient color reproduction can be realized for human being's vision on the average.

[0044] However, since it has the relation of the complementary color into level next doors by arrangement of this color, even if a high definition image is inputted perpendicularly, there is almost no change of the color in the edge section. However, like a horizontally high definition image and a display image 904, in the display of the slanting edge section, a part of color specification may be missing, and a color blot may arise in the edge section. However, a highly minute display is attained

from the normal mode of drawing 9 (A).
[0045] Now, when expressing the edge section with high definition in this way, depending on the direction of an edge, a color will change in the edge section somewhat. then, the case where a chromaticity is calculated by the 2x2 coloring-matter child, and it cannot reappear within a 2x2 coloring-matter child in consideration of the color specification between the pixels which adjoined in order to mitigate change of this color -- that error -- a contiguity pixel -- spreading -- more -- highly minute -- in addition -- and it becomes possible by taking the configuration of drawing 11 to press down fluctuation of the color in the edge section including a circumference pixel.
[0046] Drawing 11 is equivalent to the matrix circuit 405 of drawing 4 . The input picture signal RGB 1001 is inputted and it is changed into four chrominance signals YR, CB, LG, and LM through an adder 1002 in the matrix circuit 1003. Next, four colors each are changed and outputted to a liquid crystal display coloring matter child's number of gradation which can be expressed with a quantizer 1004. In addition, the matrix circuit 1003 and a quantizer 1004 may be transposed to one table 1005, and may be constituted. Four chrominance signals outputted to the liquid crystal display coloring matter child on the other hand are inputted into the block 1006 which performs a 2x2 coloring-matter child's chromaticity count. The chromaticity count block 1006 has composition containing a line buffer, records the information on front Rhine, and calculates the value of the color in a 2x2 coloring-matter child including the coloring matter child processed now.
[0047] Although the count approach is the same as that of how to calculate XYZ described previously fundamentally, since an input is an RGB code here, it becomes that to calculate by RGB is more advantageous. What is necessary is just to use a rgb stimulus value instead of a tristimulus value xyz for calculating by RGB. Moreover, it displays in fact in the combination in which an expression by four colors is possible, the colorimetry of the displayed color is carried out by RGB data, the value is recorded on a table, and the approach of changing is practical. For example, when each color 16 level display is possible, RGB each color output of 8 bits then, and RGB each color correspondence of 8 bits by 196 K bytes are attained in a 16-bit input. In addition, a color specification possible field spreads rather than this gentleman changes into four chrominance signals in the matrix circuit 1003. Now, it does in this way and the error of a 2x2 coloring-matter child's chromaticity and an input RGB code is calculated for RGB each color of every in a difference circuit 107. This error is inputted into the error buffer 1008. Drawing 12 shows signs that the error is diffused in surroundings ABCD of the pixel "X" currently processed. It may be referred to as A=B=C=D=1/4 in order to simplify a circuit as a multiplier which diffuses this error, and you may distribute equally to each pixel. In this case, a multiplier becomes unnecessary, only chooses 6 bits from a high order, and should just add them. The diffusion coefficient multiplication circuit 1009 consists of such a circuit. That is, in the diffusion coefficient multiplication circuit 1009, the multiplication of the predetermined diffusion coefficient is carried out to an error value, and the error correction data diffused in a circumference pixel are called for. Error correction data are added with an adder 1002, and input image data is amended by this.
[0048] Color specification becomes possible by the circumference pixel also by the color which cannot be expressed by the independent 2x2 coloring-matter child by this loop formation. That is, in order that a loop formation may work so that the average color difference may be set to 0 by this processing, average color specification is in agreement with the color of an input signal.
[0049] In addition, since it works so that the error of a big color may be made small in reproducing the color clearly beyond the color specification region of the electrochromatic display in this example, the color picture display from which balance shifted to the whole by the case may be made. Then, in such a case, it is not indicated by drawing 11 , but the reappearance region translation table changed between the input image data 1001 and an adder 1002 in the color reappearance region of this example is arranged, it changes into the signal of the reappearance range, and it becomes possible to mitigate the bias of color specification balance by guaranteeing average color specification. Moreover, in a display with such a color display, it is required in many cases that the brightness display should be correctly displayed rather than color specification nature. With such a case, he is CIE about control foreground-color space. L* a* b* When it changes into brightness color-difference signals, such as chromaticity space, weight is made [many] at the error of brightness, and correspondence becomes possible by carrying out processing of making weight small

to a color-difference signal.
[0050] That is, he is CIE from an RGB code about input image data at drawing 11 . L* a* b* It changes into a signal. Moreover, the output of the block 1006 which performs a 2x2 coloring-matter child's chromaticity count is also CIE. L* a* b* Rather than color specification nature, the brightness display will be correctly displayed by changing into a signal and considering as the multiplier of brightness priority depending on how choosing the multiplier in the error diffusion coefficient multiplication circuit 1009. Even if the chrominance signal which is in the outside of a color specification region somewhat by doing in this way is inputted, a luminance signal is not saturated and the bias of extreme balance decreases.
[0051] In this example, arrangement of the color of four colors is arranged, as it has a complementary color relation to a display horizontal direction. Generally a Japanese display requires resolution perpendicularly in many cases (the inclination exists also with an alphabetic character). Moreover, as a high definition alphabetic character, monochrome alphabetic character has more highly minute displays than a color alphabetic character. Then, by arranging in this way, even if it performs an achromatic color display perpendicularly and displays for every 1 coloring-matter child, a blot of a color decreases on an edge and an achromatic color display is attained.
[0052] Moreover, in this example, since it is expressing by four colors of 2x2, it becomes easy to maintain the breadth of color specification and its balance in a color space comparatively rather than three chrominance signals. That is, it is easy to become a color specification region long and slender in the green direction or the purple direction like [in 3 later mentioned, for example although there is breadth of a color with comparatively sufficient balance like drawing 6 (A) in order for four points to prescribe by four colors to three points prescribing the breadth of a color space by three colors colors] drawing 18 (A). Therefore, the reappearance region near [some] the achromatic color may become narrow. Generally, since sensibility is high, when the reappearance region near the achromatic color is narrow, as for the color near the achromatic color, unnaturalness may be visually conspicuous. However, when four points prescribe a color space, there are the descriptions, like it becomes easy to extend the color specification such near the achromatic color comparatively. Moreover, on a vision property, comparatively, to the saturation direction, since the allowed value is large, it approves also with the image output of to some extent low saturation. Thus, when it expresses as four colors, the degree of freedom of a design of the reappearance range of a color also has an advantage, like increase and an optimum design become easy. Moreover, since passage of each coloring matter child or a reflective band seldom serves as a ** band, selection of actual coloring matter etc. also becomes easy. Moreover, a highly minute display is attained by controlling brightness by one pigment unit, as stated previously. Although the error of the color in an edge arises somewhat at this time, since the sensibility of a color falls, for a certain reason, with a highly minute edge, the highly minute display also of a hardly worrisome property is visually attained in sufficient precision practical.

[Translation done.]

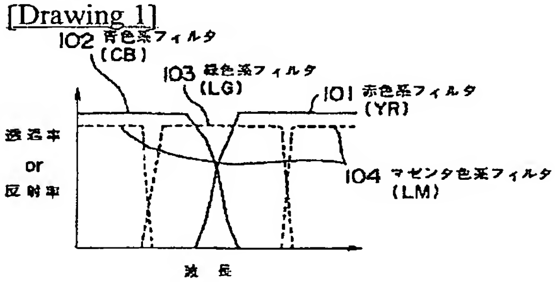
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing explaining the spectral characteristic in the color specification section in the 1st example of this invention.
[Drawing 2] Drawing showing arrangement of the color filter of the color specification section in the 1st example of this invention.
[Drawing 3] Drawing showing the structure of the cross section in the display in the 1st example of this invention.
[Drawing 4] The block diagram showing the circuit which drives the liquid crystal panel in the 1st example of this invention.
[Drawing 5] Drawing explaining the model of coloring with the liquid crystal panel in the 1st example of this invention.
[Drawing 6] Drawing showing the color specification region in the liquid crystal panel in the 1st example of this invention.
[Drawing 7] Drawing showing change of the color specification region to the optical passband in the 1st example of this invention.
[Drawing 8] Drawing showing the change of the product of the brightness and vividness to an optical passband in the 1st example of this invention.
[Drawing 9] Drawing showing the result of the subjectivity evaluation which went to the optical passband in the 1st example of this invention.
[Drawing 10] Drawing explaining the case of a usual resolution display in the 1st example of this invention, and a highly minute display.
[Drawing 11] Drawing explaining the processing block used by highly minute display in the 1st example of this invention.
[Drawing 12] Drawing explaining arrangement of the weighting factor in drawing 10 .
[Drawing 13] Drawing showing the configuration of the display in reflection/transparency combination mode which is the 2nd example of this invention.
[Drawing 14] Drawing explaining the spectral characteristic in the color specification section in the 3rd example of this invention.
[Drawing 15] Drawing showing arrangement of the color filter of the color specification section in the 3rd example of this invention.
[Drawing 16] Drawing showing the color specification region in the liquid crystal panel in the 3rd example of this invention.
[Drawing 17] Drawing explaining the spectral characteristic in the color specification section in the 3rd example of this invention.
[Drawing 18] Drawing showing the color specification region in the liquid crystal panel in the 3rd example of this invention.
[Description of Notations]
101 [-- A Magenta system color filter, 304 / -- A reflecting plate electrode, 305 / -- A liquid crystal layer, 306 / -- A TFT component, 403 / -- A graphic controller, 405 / -- A matrix circuit, 406 / -- A timing controller, 409 / -- Liquid crystal panel.] -- A red system color filter, 102 -- A blue system color filter, 103 -- A green system color filter, 104

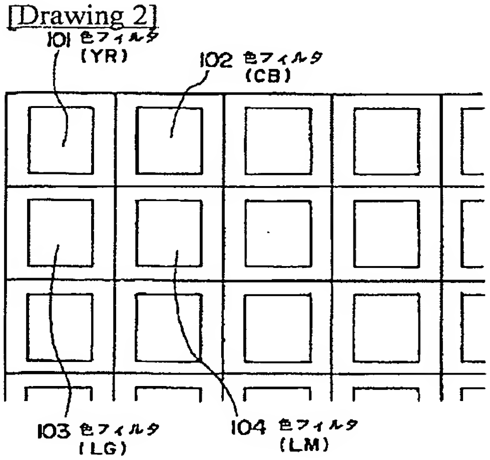
[Translation done.]

DRAWINGS

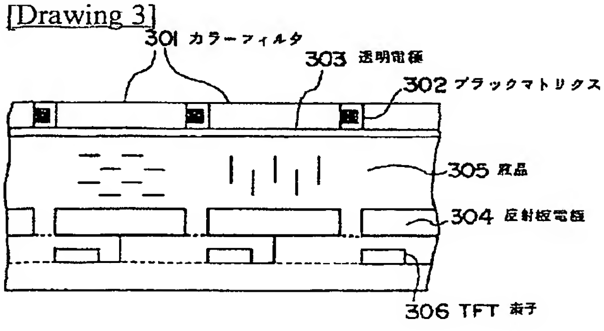
[Drawing 1]



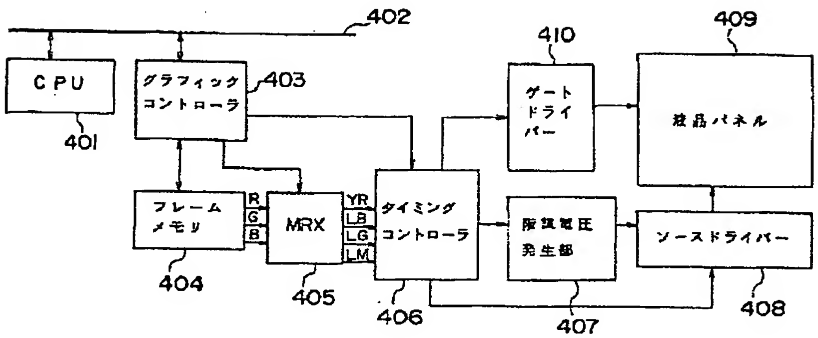
[Drawing 2]



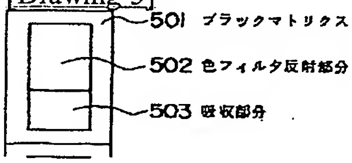
[Drawing 3]



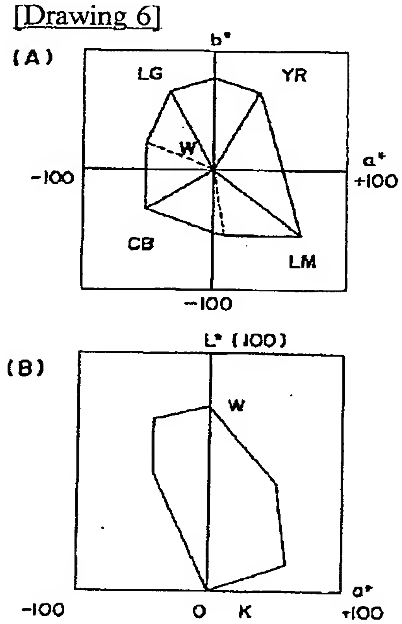
[Drawing 4]



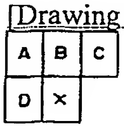
[Drawing 5]



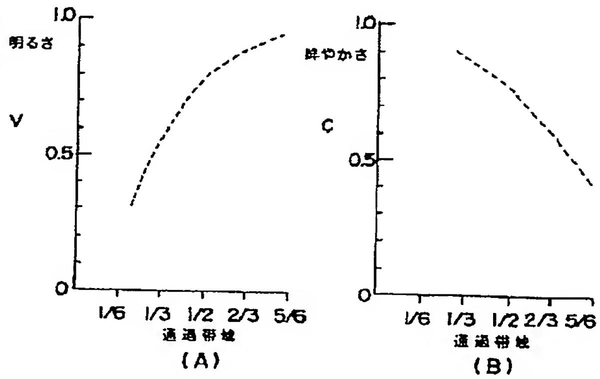
[Drawing 6]



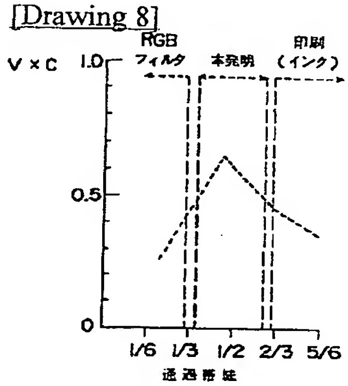
[Drawing 12]



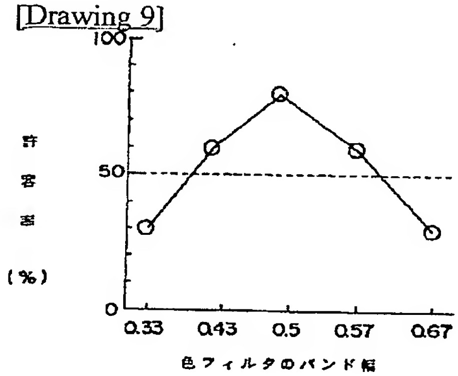
[Drawing 7]



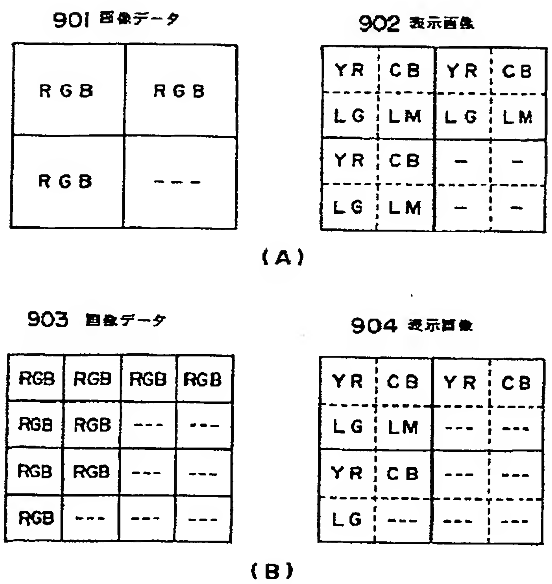
[Drawing 8]



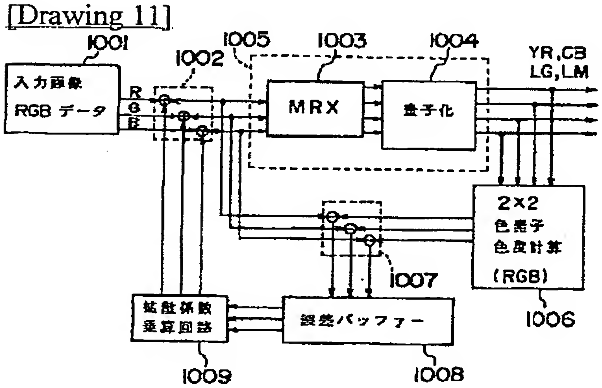
[Drawing 9]



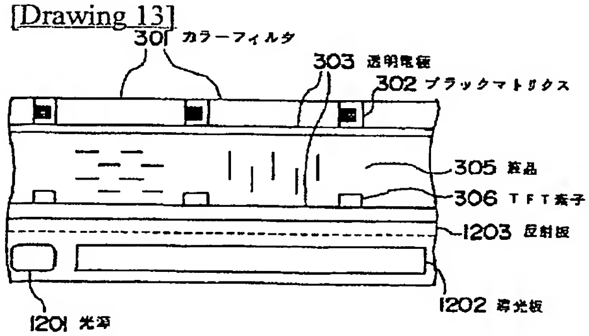
[Drawing 10]



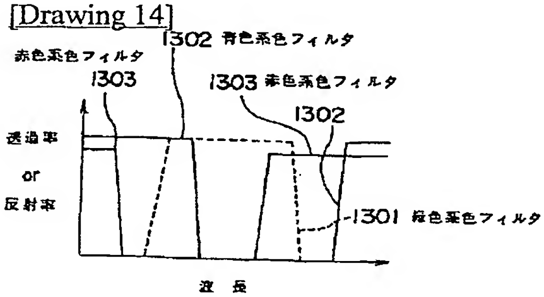
[Drawing 11]



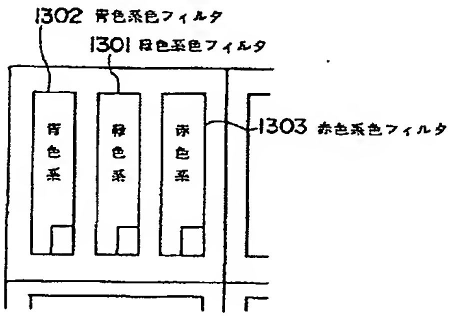
[Drawing 13]



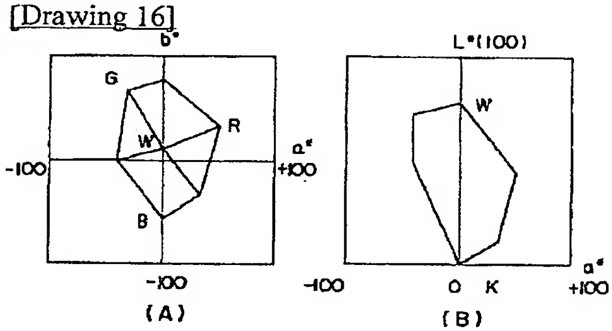
[Drawing 14]



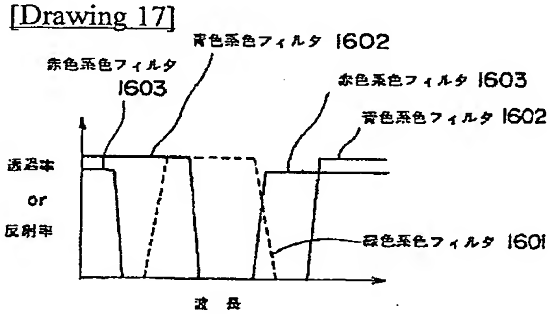
[Drawing 15]



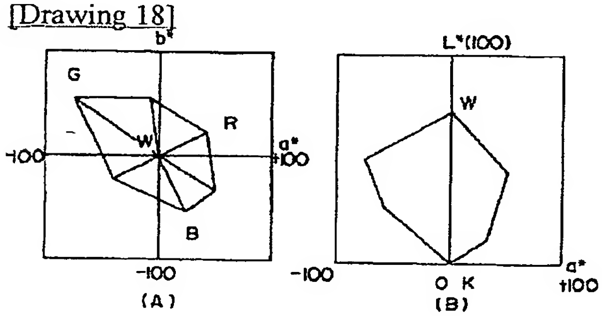
[Drawing 16]



[Drawing 17]



[Drawing 18]



[Translation done.]